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AUTHOR Wilson, John A. R.
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ABSTRACT

If motivation to read fails to develop, reading failure is the outcome. All of us have very delicately balanced neural systems for integrating incoming sensory inputs, evaluating their significance in the light of past experience, and storing the learning for future use. Autistic and hyperkinetic children apparently have unbalanced neurological systems. Neurotransmitters from neurons in the hypothalamus located at the base of the brain are important in excitation and inhibition of the nervous system. Different neurotransmitters from neurons in the hypothalamus work on and through the pituitary gland which releases eight hormones manufactured in the hypothalamus into the blood stream. To relate this to motivation, a model describing goal seeking behavior is used. Expectancies which are important in motivation are built into the sensory integration processing. Sommerhoff's theory of a lambda configuration as the basis for learning is presented and discussed as it applies to motivations and their patterns. Reinforcement and habituation are discussed. Reading teachers need to learn what to do to make reading both a challenge and a task at which students can succeed to utilize the motivation processes. (MKM)

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John A. R. Wilson

Professor of Education

University of California

Santa Barbara, California 93106

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How Motivation is Learned: A Neurological Explanation

Preconvention Institute 7

Brain Functions in Reading and Reading Disability

CS 002 408

Motivation is the result of successfully meeting challenges in life. For the reading teacher, a student will be motivated if he is challenged by the reading tasks and is able to succeed in meeting the challenge. Reading tasks can be so easy that they provide no challenge and they can be so difficult that any attempt to read ends in failure. In both cases motivation to read fails to develop and reading failure is the outcome.

Karl Pribram in Languages of the Brain (6) pointed out that organisms, including children, attempt to gain control of the environment to the extent they are able to perceive it. When such control seems feasible, based on the child's interpretation of past experience under similar circumstances, the child is motivated and reading activity ensures. When the evaluation indicates that control is not possible emotion rather than motivation is the result with stereotyped responses or avoidance activity as the result. Many reading teachers are able to visualize the emotional response that Pribram sets in contrast to motivation.

All of us have very delicately balanced neural systems for integrating incoming sensory inputs, evaluating their significance in the light of past experience, and storing the learning for future use. Sometimes these balanced systems get out of order. Bob Snyder has described how hyperkinetic children function badly because they are unable to use reinforcement mechanisms efficiently. Two doctoral students at the University of California Santa Barbara are working with autistic children. Autism is an etiology that is behaviorally unsettling to parents, teachers, and to therapists. These young people do not integrate incoming stimuli well. Often they walk into things without seeing them. With some it is possible to explode a starting pistol close to them without getting a

reaction even on their EEG tracings. These same children ordinarily respond immediately to the sound of a candy wrapper being opened even when the sound comes from across the room. They attend to some stimuli but not to others in the same modality. They self-stimulate for long periods of time, rocking back and forth, watching their fingers as they move them in the light, or moving a bit of spittle around and around with their tongues. Even more disturbing is the tendency of many of them to self destructive activities such as banging their heads on sharp objects, chewing at fingers until they are down to the bone, or pulling on a shoulder until the flesh is gone. In these children the control mechanism for integration and for motivation is seriously out of order.

In 1954 Olds (5) located pleasure centers in the hypothalamus of the brain of a rat. A rat would go to great lengths to do whatever was necessary to set up the stimulation which came to it through implanted electrodes. At about the same time Delgado, Roberts and Miller (2) located punishment centers that animals would avoid stimulating and would work very hard pressing bars or performing other activities that would keep such stimulation from occurring. For a time it looked as though motivation might be just linking certain activities with the pleasure centers and linking others with the punishment centers. Reading activities would be linked with pleasure connections in the children who were motivated to read. The same activities would be linked with punishment centers in those who were turned off to reading. The work with autistic children has shown that this explanation is overly simple. They self-stimulate very much as the rat does for electrode charges but their learning is very limited. Simple pleasure connections can be downright dangerous

unless there is some kind of control that meters and shuts the system down or controls the connections in some way.

The key to understanding what is going on is knowledge of the way neurons interrelate and pattern their activity. The neurons are controlled by their relationships with other neurons which stimulate them to fire or inhibit them from firing. Since a single neuron may have contact with as many as ten thousand other neurons these patterns can get very complex. When a neuron or neuron group is activated it ordinarily is surrounded by a group of cells that are inhibited. This patterning of excitation and inhibition seems to have an important bearing on what is learned, Sommerhoff 1974 (7).

Excitation and inhibition are apparently dependent on neurotransmitter substances and on whether excitor or inhibitor sites are activated. These neurotransmitters are very important in many of the motivation processes. The beginning of their manufacture starts in the cell body and the products are transported to the synaptic knobs where the manufacturing process is completed and the transmitter substance is stored. When the neuron or the synaptic knob receives a message in the form of an electrical impulse, some of the synaptic vessicles move to the presynaptic membrane, open the membrane and discharge the transmitter substance into the synaptic cleft. A possible difference in the effects of excitory and inhibitory action is suggested by Eccles (3). The transmitter molecules which are excitory may open a wide enough channel for sodium ions to flow inward while the inhibitory transmitters open channels that are too small for sodium ions to flow in but allow potassium ions to flow out and chlorine ions, which are negative, to flow in. Eccles is at pains to point out

that the exact nature of the excitation and inhibition process was not known but that ion size definitely seemed to be involved.

One further point needs to be made. The transmitter substance is not left lying around in the synaptic cleft. It is either changed in structure or taken back into the synaptic knob where it is either reused or re-manufactured. The neuron is a chemical manufacturing plant, with a transport system for carrying the chemicals, storing them, releasing them, and cleaning up the garbage when the process is finished.

The hypothalamus is an exceptionally important part of the motivation system. It is in the hypothalamus that the motivation to eat and to stop eating, to drink and to stop drinking are located. The areas most sensitive to pleasure and punishment stimulations are found in the medial forebrain bundle of the hypothalamus. Sexual excitation and impotence or frigidity have their origins in the neurotransmitters of the hypothalamus. The hypothalamus is located at the base of the brain, at the upper end of the brain stem and has connections to the limbic system, the thalamus, the reticular formation where integration takes place, and at least indirectly to the cortex.

A review of the way different neurotransmitters from neurons in the hypothalamus work on and through the pituitary gland seems necessary to understand how complex the motivation process is. You remember that the pituitary gland is called the master gland of the body. The hypothalamus is the master of the master gland. Six hormones that control the thyroid gland, the adrenal glands and the sex related systems are controlled by separate releasing hormones that are manufactured in the neurons of the hypothalamus. Things are even more complicated because there are stop

factors as well as go factors involved. When the idea was proposed thirty years ago by G. W. Harris (4) of the University of Oxford there was a problem. No neural connections existed from the hypothalamus to the anterior or front part of the hypothalamus. It is now known the connection is made through capillaries which carry the releasing hormones to the anterior pituitary which releases hormones into the blood stream and finally the glands release hormones that do the work, a tricky system.

In the posterior pituitary the system is a bit simpler. Vasopressin and Oxytocin, two hormones that control reabsorption of water from the kidneys into the blood stream, stimulate the contraction of the uterus during childbirth, and release milk during lactation, are manufactured in the neurons of the hypothalamus and feed directly down the axon to the posterior pituitary where they are stored until they are called for by a triggering device when they are released directly into the blood stream.

You can see that these eight hormones that are manufactured in the hypothalamus gives that part of the brain a very important function in the motivational levels of the human being even without the more direct involvement through the pleasure and punishment areas and the motivation systems concdrned with eating, drinking and stopping these activities. These motivational systems are pretty basic but they are quite a long way from the teacher in the classroom struggling with Johnny and his motivation to avoid reading, or as Pribram calls it emotion to reading. Gerd Sommerhoff (7) developed some models that explain goal seeking behavior -- that is, motivated behavior -- in language that helps scientific behaviorists accept the idea that there might be something to living organisms acting like living organisms and not like programmed automatons. He developed directive correlations and used them to develop

mathematical models for describing goal seeking behavior. He points out that these models have been useful in describing the operation of freely homing missiles which are able to locate a target and to change course to compensate for evasive action by the target. Antibalistic missiles are a prime example of locating a target and seeking it out even when it changes course. The principle involves servo mechanisms that have feedback loops that compare input information from radar type sensors with expectancies that have been programmed into the missile's memory. It is reassuring in a strange way to find that goal-seeking can be thought of as real in the scientific world as well as the subjective world in which all of us live.

Input information is critically important for the goal-seeking activity to be effective. As you are well aware the input information starts with sensory stimulation but this input is integrated with past similar information to build expectancies. These expectancies incorporate experience with visual change (to represent other sense experience) that results from seeing a room or a wood from different angles, that stabilizes the scene as the head is rotated, and that involve visual memories that allow movement in the space even when blindfolded. The process of building expectancies is undoubtedly rooted in phlogenetic organization and much of the rest of the processing is probably ontogenetic in nature.

These expectancies are important in motivation because the integration processing includes feedback loops from the limbic and hypothalamic structures that include intimations of danger or of euphoria depending on the past experiences. Many of these overtones probably are the result of choices that were made in the past. It is probably necessary to keep in mind that phylogenetically the visual and mental processes were developed

in a context of primitive survival rather than in a reading classroom in a school. The school still has to operate with the kinds of processing equipment that was adequate and necessary for life in primitive conditions. Judging by the dense packing of neural cell bodies in the integrative systems the process of forming expectancies is very complex.

Sommerhoff postulated the possibility of a lambda configuration as the basis for learning. A lambda system has three characteristics. 1. A number of input channels are shared by all excitory neurons of the network. 2. The excitory neurons operate with forward inhibition potential so that only the neurons that are most receptive excite. 3. The synapses of the shared input channels can undergo lasting changes as the result of experience. Inhibition is very important as an enhancer of contrast as well as a channeller of inputs.

The concept allows for shaping types of gradual changes but makes sudden destruction of knowledge difficult. It also allows for reinforcement patterns that conform to behavior modification experience. The concept also provides for improvements in performance due to short circuiting, essentially the process as envisioned is through shortening a chain of stimuli so that the original stimulus can lead directly to the final action. The feedback and feed forward loops in the system would take care of time experiencing.

This concept of how learning takes place would fit neatly into what we know about motivations and their patterns. The major difficulty with the Lambda configuration is the same one that is true of all cell assembly models. "How do you account for the know- ability of the neural system to suffer extensive injury without specific memory losses?" The answer

to this question probably is bound up with the nature of the memory consolidation process that changes immediate memory into long term memory.

The process of inhibition of neural processes is a reminder that it is often very important to learn not to do something as well as to learn to do something else. Also since our learning processes have been developed for practical purposes, built into the system are processes for tuning out stimuli that are no longer providing information. In the simplest case this tuning out is called habituation, a process, as you know, by which we stop hearing sounds that continue as repetitions, and stop feeling pressures that are fairly constant. We almost never hear our hearts beat and we are completely unconscious of the 15 pounds of pressure per square inch that is acting on us at all times.

Berlyne (1969) (1) has pointed out that reducing uncertainty, complexity, and conflict is reinforcing. We are so constructed that if we do not have problems to solve in our lives we go out and create them. You are all familiar with the terrible time people had who were put in quiet rooms with very low light and cuffs on their arms to remove stimulation from tactile senses. They were unable to stand this kind of deprivation for more than a short time. You all get bored if there is not something going on that is changing and new. Our neurological systems were set up to cope with information coming from many senses that needed accurate interpretation for survival. Built into the system is the reinforcement mentioned by Berlyne for meeting challenges. As you stop and think about it you all find satisfaction in accomplishing a task that was a real challenge. One that you were not sure you were really able to handle but when you made it you were almost as pleased as one

of your forebearers was when he managed to kill a bear that was quite willing to kill him if he was careless in the way he went about his task. The importance of positive reinforcement has been underlined in the success of behavior modification schedules. These schedules have been particularly successful in autism, speech correction, and disruptive behavior situations where it was a challenge to do what needed to be done and where the goals were quite clear. The other end of the scale, where challenge was needed, have been overlooked because it has been thought that if m&m's were good in the difficult situations they must be equally good all across the board. I am claiming that there is a stop mechanism for this kind of reinforcement just as there is a stop mechanism for eating. Too much sweets is bad for the appetite and it seems to be bad for motivation as well.

The combination of habituation and boredom with things that become too easy and excitement and reinforcement with tasks that provide a real challenge has enormous significance in any study of motivation and how it is learned. It also has a very great amount of significance for reading teachers as they are thinking about how they can motivate children to want to read and to avoid motivating them to want to avoid reading.

How many children come into classes already able to do the beginning assignments and even all that will be done for the first six months? What does this mean in terms of habituation, turning off, or worse? How many come without the necessary readiness so that there is no chance for meeting the challenge the task provides? There really wasn't much reinforcement in losing to the bear in the old days and the neural system is still tuned in the old patterns. In the upper grades how challenging are the stories? How challenging are the interpretive assignments? How much the same are

they from day to day? Are the students habituating and turning the whole thing off? What can teachers do to make reading both a challenge and a task at which they can succeed? When they can answer that basic question they can teach motivation because of the way our neural systems work.

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